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DISSEMINATION OF AUDIOLOGICAL STANDARDS

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1. INTRODUCTION

Although a wide variety of tests and physical measurements are routinely made in diagnostic audiology, at present it is only in the area of conventional pure tone audiometry that accepted specifications and a system for traceable instrument calibration exist.

2. PRINCIPLES OF CALIBRATION AND TRACEABILITY

Many of the transducers and pieces of equipment used in audiometry are notoriously susceptible to shock, changes in temperature and even the manner in which the equipment is used. If audiometers are to be kept correctly calibrated it is essential that their calibration is not a once and for all act but part of a continuing checking process. In collaboration with the Department of Health and Social Security the National Physical Laboratory has developed a system based on secondary standards and reference devices which provide links to the appropriate national standards and allow the user to check and calibrate his audiometers at regular intervals.

2.1 Secondary standards

A secondary standard is a stable transducer whose output, under specified conditions of use, is known in terms of the national primary standard.

2.2 Reference devices

A reference device is also a stable transducer, but unlike a secondary standard, its sensitivity does not have to be known separately by absolute calibration. Its function is to provide a means of checking the performance of the test equipment with which it is specifically associated.

A reference device thus provides a check on the total test equipment to which it is applied but it cannot be used to correct the equipment being calibrated since any observed discrepancies may be the result of faults in the test equipment itself. It is desirable therefore that reference devices are maintained in pairs to allow an element of cross checking.

2.3 Calibration chain

For both air and bone conduction the calibration of the transducer which delivers sound to the patient is carried out by placing this transducer on the appropriate ear or skull simulator, the output of which is connected to a measurement amplifier and associated filters. Traceability to the national standard is achieved either by absolute calibration of the ear or skull simulator, or by using a secondary standard at a fixed frequency and the

relative frequency response of the simulator. If in addition to the essential calibration, a reference device is used, values may be recorded on the test certificate which can be used as a check, not only of the calibrated components but also of the test equipment itself. In practice the test is straightforward and entails connecting the test equipment together and using the reference device, driven at a known voltage at each of the audiometric test frequencies, to obtain a reading at the output of the test equipment. The importance of this test lies in the fact that the user can himself repeat the test, thus ensuring the integrity and correct connection of the whole calibration test equipment. Experience gained over the last few months, particularly with bone vibration equipment, has shown the value of this additional test.

3. CALIBRATION EQUIPMENT

3.1 Air conduction

When requesting calibration of equipment for audiometric earphones it is recommended that the following equipment is submitted for test:

Sound level calibrator
Acoustic coupler or artificial ear
Microphone
Sound level meter and filters
A pair of TDH-49 earphones fitted with MX-41/AR cushions
Appropriate connecting leads

The recommended calibrations and tests are then as follows:

The sound level calibrator is calibrated against a standard condenser microphone held at NPL whose sensitivity has been determined by the reciprocity method and thus acts as a single frequency secondary standard.

The relative frequency response of the microphone and test equipment, at the audiometric test frequencies, is determined by a substitution method against a standard microphone.

These two calibrations provide the necessary link to the national standard of sound pressure level. The sound level calibrator providing the sound pressure level at a fixed frequency, and the microphone and test equipment frequency response the sound pressure level at the remaining test frequencies.

The equipment is then linked together and the reference earphones type TDH-49 applied to the artificial ear or coupler. The earphones are driven at a known voltage at each of the audiometric frequencies and readings recorded by the sound level meter are written into the calibration certificate. Subsequently by carrying out the same test the user is able to verify his equipment by ensuring that he is able to reproduce the readings made by the standardising laboratory.

3.2 Bone conduction

It is recommended that the following test equipment is submitted when requesting calibration of equipment for bone vibrators:

Artificial mastoid
Sound level meter and filters
A pair of B72 bone vibrators
Appropriate connecting leads

In this instance absolute calibration of the sensitivity of the artificial mastoid at the audiometric frequencies is carried out and establishes traceability to the national standard of acceleration.

With the test equipment linked together, analogous to the case of air conduction, the B72 vibrators are used as reference devices.

To establish the absolute level it is necessary for the sound level meter to be set to read true volts. This may be done by using the meter's own internal reference voltage or by application of a known external voltage to the sound level meter. This electrical calibration can be circumvented if a suitable accelerometer and vibrator are used as a secondary standard. Routine accelerometer calibration is carried out by approved laboratories of the British Calibration Service, not by NPL.

3.3 Ancillary equipment

If the user is to make proper use of the figures supplied on the calibration certificate for the reference devices it is tacitly assumed that properly calibrated voltage and frequency measuring equipment is available. These calibrations are available through the British Calibration Service.

3.4 Choice of reference devices

The reference devices recommended are of American origin and are considered to be the most stable and readily available devices for this purpose. Whilst being suitable for use as a reference device the B72 bone vibrator is not recommended for use on audiometers because of the high level of air radiated sound, particularly at high frequencies.

4. CALIBRATION INTERVALS

Secondary standards should be calibrated at least biennially by a standardising laboratory. If the recommendations made concerning the use of reference devices are carried out the remaining equipment need only be calibrated when discrepancies are found using the reference devices. It is therefore highly desirable that a pair of reference devices are maintained to ensure that observed changes lie with the test equipment and not with the reference devices.

Should microphone or artificial mastoid require recalibration the reference devices and associated test equipment should also be submitted to the standardising laboratory for testing.

Further details and methods of acoustic calibration are to be found in the NPL booklet "Measurement Services - Acoustics", available free of charge from the National Physical Laboratory.